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Some Physico-chemical Properties of the Habitat of West African Manatee *Trichechus senegalensis Link 1795* along River Benue, Nigeria.

Algunas propiedades fisicoquímicas del hábitat del manatí de África occidental *Trichechus senegalensis* Enlace 1795 a lo largo del río Benue, Nigeria.

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ABSTRACT

Some physico-Chemical parameters of Manatee habitat along river Benue were evaluated. The river was divided into four segments; Makurdi, Abinsi, Gbajimba and Gbaji. In each segment, ten (10) sample points were selected and the following parameters; Temperature, dissolved solid (DO), pH, Total dissolved solid, (TDS) Electrical conductivity (EC) and Biological oxygen demand (BOD) were measured. Data collected was subjected to statistical analysis. The result indicated that there were significant differences in the pH, Electrical conductivity, and Biological oxygen demand (BOD) among the four study areas. The mean pH ranged between 6.94 to 7.09, EC ranged between 47.76 µs/cm to 55.91 µs/, dissolved oxygen was between 15.82mg/L in Makurdi to 18.50mg/L in Abinsi, mean Temperature moved between 27 °C to 29°C in Makurdi to 33 °C to34°C in Gbaji, the total dissolved solids ranged from 44.46 mg/l in Abinsi to 56.74mg/L in Gbajimba while Biological Oxygen demand (BOD) was least at Gbajimba(3.03 mg/L) and Makurdi with 5.49mg/L It is therefore suggested that continuous monitoring of the water health of the river be sustained for the survival of the west African manatee.

RESUMEN

Se evaluaron algunos parámetros fisicoquímicos del hábitat del manatí a lo largo del río Benue. El río se dividió en cuatro segmentos; Makurdi, Abinsi, Gbajimba y Gbaji. En cada segmento, se seleccionaron diez (10) puntos de muestra y los siguientes parámetros; Se midieron la temperatura, el sólido disuelto (OD), el pH, el sólido disuelto total (TDS), la conductividad eléctrica (CE) y la demanda biológica de oxígeno (DBO). Los datos recopilados se sometieron a análisis estadístico. El resultado indicó que había diferencias significativas en el pH, la conductividad eléctrica y la demanda biológica de oxígeno (DBO) entre las cuatro áreas de estudio. El pH promedio varió entre 6.94 y 7.09, la CE varió entre 47.76 µs / cm a 55.91 µs /, el oxígeno disuelto fue entre 15.82mg / L en Makurdi a 18.50mg / L en Abinsi, la temperatura media se movió entre 27 oC a 29oC en Makurdi a 33 oC a 34oC en Gbaji, el total de sólidos disueltos varió de 44.46 mg / l en Abinsi a 56.74mg / L en Gbajimba, mientras que la demanda de oxígeno biológico (DBO) fue menor en Gbajimba (3.03 mg / L) y Makurdi con 5.49mg / L It Por lo tanto, se sugiere que el monitoreo continuo de la salud del agua del río se mantenga para la supervivencia del manatí de África occidental.

INTRODUCTION

The West African Manatee (*Trichechus senegalensis Link 1795)* belongs to one of the only three living species in the order sirenia (Reynold and Odeh, 1991) and it is found in the coastal areas of tropical and substropical Western Africa. The second species, Amazonian Manatee (*Trichechus Inuingui Link 1795s*) is found only in the freshwater areas of Amazonian basin, while the West Indian Manatee (*Trichechus Manatus Link 1795)* are found from the southern united states to the north Eastern coast of Brazil (Lefevbre *et al.* 2000) The West African Manatee is an aquatic mammal with a robust fusiform body that is compressed dorsoventrally. The body has no hand limbs but a paddle-shaped forelimbs or flippers with three to four nails that are presents on the dorsal surface of each flipper. The body tapers to a spatulate dorsoventrally flattened tail (Esenowo *et al.* 2014). according to Deusch *et al.* (2003), the distribution and abundance of manatees are affected by temperature and availability of vegetation. they also reiterated that increase in salinity (pH) greatly influence the distribution of manatees and also their reproduction, feeding and calving. Perrin *et al.* (2001) said that the West African manatee are limited to waters of $18C^0$ to 27^0C.

An organism's capacity and ability to survive and reproduce successfully in any habitat is a function of how healthy its environment is, physico-chemical parameters of waters are known to affect the biotic component of an aquatic environment in various ways (Okayi *et al.* 2013).

Smith (1993) reported that temperature is the overriding factor in determining the geographic extent of suitable habitat available to West Indian manatee (*Trichechus manatus* Link 1795). while Ugwumba (1993) stated that physico-chemical parameters affect the biotic component of an aquatic environment in various ways. Hence, the physico-chemical parameters of Manatee habitat along River Benue was undertaken to assess the water health of the River.

MATERIALS AND METHODS

Study Area: The study area is a section of the River Benue which lies between latitudes 07^0 $49^{//}$N and 07^0 $52^{//}$N and longitudes $08^036^{//}$ and $08^040^{//}$E. The major tributaries that flow into the River Benue along this area are Rivers Guma from the north, Mu from the south, Katsina-Ala from the north, Gwer and Rukuba from the north.

The River Benue takes its origin from the Adamawa highlands in the western Cameroun and it is the largest tributary to the River Niger with which it confluences at Lokoja, in Kogi State. The Benue River enters Nigeria a few Kilometres East of Yola in Adamawa State, flowing westwards for a distance of 780km before joining. River Niger in Lokoja. It flows through Adamawa, Taraba, Benue and Kogi States. Unlike other African Rivers the River Benue flows free of rapids and waterfalls.

The study area has distinct dry and wet seasons of Tropical Climate. The rainy season last from April to October and is between 1,240mm to 1,440mm. The monthly Temperature is between $28.5C^0$ -$36C^0$ and may rise to $38C^0$ in March to April.

Data Collection: The River was purposively divided into four (4) sampling areas that are close to human settlements namely, Gbajimba, Abinsi, Makurdi and Gbaji, In each sampling site 500m length of the River was selected and moving in a boat, ten (10) sampling points were randomly selected for water parameter analysis using electronic water testing kits.
Water temperature, pH, Dissolved Oxygen (DO), Electrical conductivity (EC), Total dissolved solids (TDS) and Biological Oxygen demand (BOD) were recorded in designed recording sheets. The data was analyzed using Minitap 17 for Analysis of variance (ANOVA) and Genstat 12 for diversity indices.

RESULT AND DISCUSSION

The result of the various water quality parameters in the four sample sites are presented in table 1, 2, 3 and 4, while table 5 show the variation in water quality parameters in the 4 sample sites. In Abinsi (Table 1) there is significant differences in pH amongst the various sample

points, while electrical conductivity did not indicate any significant differences. Dissolved Oxygen (DO) show significant differences amongst the sampling points as well as Temperature and Total Dissolved solid (TDS), while there was no significant difference with biological oxygen demand (BOD). The same trend, is observed in the Gbajimba study site (Table 2). In Gbeji, pH does not indicate any significant differences amongst the various sampling points as well as dissolved Oxygen (DO) Temperature, and Total dissolved solid (TDS). In Makurdi study area, pH does not reflect any significant differences amongst sampling point while Electrical conductivity (EC), Dissolved Oxygen (DO), Temperature. Total Dissolved Solids (TDS) and Biological Oxygen demand (BOD) all indicate significant differences amongst sampling points.

A comparison of the water quality parameters among the four study areas (Table 5) shows that there exist no significant difference between Abinsi and Gbajimba whereas slight differences do exist between Gbeji and Makurdi. Electrical Conductivity (EC) show significant difference between Abinsi and Gbajimba, no differences between Gbajimba and Gbeji as well as between Abinsi and Makurdi. Temperature and Total dissolved Solids (TDS) does not indicate any significant differences among the study areas while Biological Oxygen demand (BOD) indicates significant difference among the study area.

The pH trend within the period of study (Fig. 1) indicate gradual increase in Abinsi from May to June when it stabilizes, and dips down gradually to August and climbs steadily up to October .In the Gbeji study area, the pH increases gradually throughout the period of study while in Gbajimba, it dips down in June before increasing steadily to September. In the Makurdi study area the pH rises gradually reaching its peak in September before dipping down in October.

The result of the trend in Electrical conductivity (Fig 2) indicate slow and gradual rise in Abinsi, wide fluctuations in Gbeji -Kendev, as well as Makurdi study area. The trend in changes in the Dissolved Oxygen (Fig 3) in the study area indicate gradual and steady drop in Abinsi and Gbeji -Kendev areas; In Gbajimba there was a sharp rise between May to June and subsequently a gradual and steady drop to the month of October. Temperature trend (Fig.4) in all study areas indicate wide fluctuations but in all ranging between $25C^0$ to $30C^0$. The trend for Total dissolved solids (Fig. 5) show only slight variation in Abinsi and Makurdi and in Gbeji there was a sharp drop between May to June, Slight rise and gradual dropping to the month of October.

Table 1:Variation of Water Quality Parameters at Sampling Points in Abinsi study area

	Water Quality Parameters

Sampling Points	PH	EC (µS/cm)	DO (Mg/L)	Temp (°C)	TDS (Mg/L)	BOD (Mg/L)
P1	6.98±0.12^{bc}	53.50±1.20	16.83±1.56^{bc}	28.21±0.68^{c}	40.17±1.72^{c}	1.14±0.59
P2	7.13±0.16^{abc}	55.33±1.84	16.83±1.33^{bc}	28.81±0.56^{abc}	42.67±1.98^{abc}	1.16±0.58
P3	7.20±0.10^{ab}	56.50±2.92	16.17±1.47^{c}	28.65±0.54^{bc}	41.67±1.41^{bc}	1.75±0.88
P4	7.33±0.04^{a}	56.33±2.67	20.50±1.31^{ab}	29.15±1.14^{abc}	44.50±1.63^{abc}	1.45±0.95
P5	7.21±0.08^{ab}	59.33±4.21	21.17±1.51^{a}	29.00±0.59^{abc}	44.17±1.30^{abc}	1.53±0.97
P6	7.10±0.14^{abc}	57.17±2.50	19.50±1.50^{abc}	30.30±0.17^{ab}	46.67±1.36^{a}	1.26±0.66
P7	7.03±0.07^{abc}	54.33±3.17	20.66±0.95^{ab}	30.41±0.20^{a}	47.17±1.89^{a}	1.18±0.60
P8	6.88±0.16^{c}	55.33±3.26	18.83±0.60^{abc}	30.20±0.63^{ab}	47.17±2.04^{a}	1.23±0.57
P9	7.00±0.08^{bc}	55.17±2.63	17.17±1.58^{bc}	30.00±0.45^{ab}	45.33±1.56^{ab}	1.28±0.66
P10	7.01±0.04^{bc}	56.17±2.97	17.33±1.84^{abc}	30.16±0.54^{ab}	45.17±1.62^{ab}	1.17±0.58
P-Value	0.04	0.96^{ns}	0.04	0.04	0.05	0.95^{ns}

Means on the same column with different superscript are statistically significant ($p<0.05$); ns = not significant

Table 2: Variation of Water Quality Parameters at the Sampling Points in Gbajimba study area

Sampling Points	Water Quality Parameters					
	PH	EC (µS/cm)	DO (Mg/L)	Temp (°C)	TDS (Mg/L)	BOD (Mg/L)
P1	7.04±0.12^{ab}	44.45±4.39	17.17±2.83^{ab}	29.16±0.67^{ab}	47.50±2.47^{bc}	0.56±0.18
P2	7.24±0.14^{ab}	49.50±5.30	17.28±2.05^{ab}	29.86±0.34^{ab}	48.25±0.56^{b}	0.58±0.04
P3	7.16±0.18^{ab}	46.67±4.54	15.83±1.28^{b}	30.56±0.53^{ab}	46.83±4.74^{c}	0.66±0.03
P4	7.02±0.39^{ab}	47.67±4.70	20.67±2.76^{ab}	30.63±0.66^{a}	48.67±2.33^{b}	0.69±0.02
P5	6.77±0.13^{b}	47.83±4.67	23.00±2.48^{a}	30.61±0.42^{a}	50.33±2.29^{a}	0.65±0.03
P6	7.05±0.13^{ab}	49.50±4.97	20.33±2.59^{ab}	30.46±0.52^{ab}	49.50±1.63^{ab}	7.26±4.19
P7	7.14±0.12^{ab}	49.17±4.59	17.95±2.23^{ab}	25.78±5.04^{b}	51.17±1.45^{a}	3.68±3.00
P8	7.57±0.23^{a}	48.67±4.81	16.67±1.89^{b}	29.55±0.73^{ab}	44.17±2.06^{c}	5.32±4.62
P9	7.09±0.12^{ab}	46.67±4.67	18.17±1.11^{ab}	29.13±0.89^{ab}	45.50±1.90^{c}	5.27±4.59
P10	7.55±0.27^{a}	47.50±4.73	16.13±1.73^{b}	29.76±0.63^{ab}	48.00±1.29^{b}	5.61±4.83
P-Value	0.04	0.99^{ns}	0.03	0.04	0.04	0.66^{ns}

Means on the same column with different superscript are statistically significant ($p<0.05$); ns = not significant

Table 3: Variation of Water Quality Parameters at the Sampling Points in Gbaji study area

Sampling Points	Water Quality Parameters					
	PH	EC (µS/cm)	DO (Mg/L)	Temp (°C)	TDS (Mg/L)	BOD (Mg/L)
P1	7.07±0.09	39.17±6.07^{b}	15.67±1.28	28.18±0.29	44.50±2.33	6.33±0.27^{a}
P2	7.14±0.06	48.50±3.81^{ab}	16.17±2.01	28.16±0.37	43.50±1.45	5.93±0.87^{ab}
P3	7.09±0.05	49.00±3.95^{ab}	17.00±1.77	28.81±0.57	46.50±2.47	4.96±0.87^{b}
P4	7.06±0.10	54.56±5.06^{a}	16.00±1.84	28.85±0.42	51.17±1.33	6.06±0.27^{ab}
P5	6.93±0.13	54.67±5.06^{a}	17.17±2.01	31.53±1.43	46.50±8.72	6.13±0.29^{ab}
P6	7.08±0.14	56.00±5.08^{a}	14.83±1.51	29.25±1.07	54.50±2.68	5.73±0.39^{ab}
P7	6.19±0.03	50.17±4.46^{ab}	16.33±1.41	29.60±0.25	52.50±3.16	6.08±0.39^{ab}
P8	7.03±0.05	49.50±3.91^{ab}	17.00±1.56	29.43±0.51	54.17±4.66	5.90±0.48^{ab}
P9	7.06±0.10	50.17±3.94^{ab}	17.17±1.22	29.16±0.58	51.33±5.36	6.36±0.40^{a}
P10	7.13±0.10	51.00±2.91^{ab}	15.50±1.45	30.20±0.28	51.67±3.03	6.06±0.44^{ab}
P-Value	0.79^{ns}	0.04	0.98^{ns}	0.44^{ns}	0.48^{ns}	0.04

Means on the same column with different superscript are statistically significant ($p<0.05$); ns = not significant

Table 4: Variation of Water Quality Parameters at the Sampling Points in Makurdi study area.

Sampling Points	Water Quality Parameters					
	PH	EC (µS/cm)	DO (Mg/L)	Temp (°C)	TDS (Mg/L)	BOD (Mg/L)
P1	6.84±0.07	43.83±0.54^{c}	14.53±1.57^{ab}	28.28±0.25^{c}	41.00±0.81^{b}	5.66±0.33^{ab}
P2	6.89±0.08	50.33±0.76^{bc}	14.26±0.66^{b}	29.33±0.53^{bc}	41.33±0.80^{b}	5.00±0.39^{b}
P3	7.02±0.08	53.17±3.57^{ab}	13.87±1.73^{b}	29.21±0.46^{bc}	41.66±0.55^{b}	5.43±0.40^{ab}
P4	6.94±0.14	58.50±3.20^{ab}	13.50±1.36^{b}	29.30±0.61^{bc}	47.17±1.87^{a}	5.58±0.44^{ab}
P5	6.96±0.14	59.33±3.44^{ab}	14.20±1.63^{b}	28.81±0.30^{bc}	45.83±1.89^{ab}	5.13±0.42^{ab}
P6	7.03±0.07	58.83±3.85^{ab}	17.00±1.63^{ab}	29.11±0.39^{bc}	47.17±2.29^{a}	5.26±0.32^{ab}
P7	6.97±0.08	57.67±4.01^{ab}	18.83±1.68^{a}	30.70±0.47^{a}	48.17±2.32^{a}	6.18±0.11^{a}
P8	6.94±0.07	54.00±3.64^{ab}	17.33±1.84^{ab}	29.91±0.58^{ab}	47.33±2.59^{a}	5.75±0.35^{ab}
P9	6.69±0.12	55.17±2.23^{ab}	17.50±1.65^{ab}	29.15±0.58^{bc}	47.50±2.06^{a}	5.61±0.47^{ab}
P10	6.89±0.14	52.17±2.20^{ab}	17.17±1.11^{ab}	28.88±0.44^{bc}	45.67±1.84^{ab}	5.30±0.39^{ab}

P-Value	0.96^{ns}	0.01	0.03	0.03	0.02	0.04

Means on the same column with different superscript are statistically significant ($p<0.05$); ns = not significant

Table 5: Variation of Water Quality Parameters by Water Bodies in the study area

Sampling Points	Water Quality Parameters					
	PH	EC (µS/cm)	DO (Mg/L)	Temp (°C)	TDS (Mg/L)	BOD (Mg/L)
Abinsi	7.09±0.03^{a}	55.91±0.85^{a}	18.50±0.46^{a}	29.49±0.20	44.46±0.56	1.31±0.21^{c}
Gbajimba	7.16±0.06^{a}	47.76±1.39^{b}	18.32±0.69^{a}	29.55±0.52	56.73±0.99	3.03±0.94^{b}
Gbeji	7.05±0.03^{ab}	50.27±1.41^{b}	16.28±0.48^{b}	34.33±5.02	49.63±1.29	5.95±0.13^{a}
Makurdi	6.94±0.03^{b}	54.30±1.05^{a}	15.82±0.50^{b}	29.27±0.16	45.28±0.63	5.49±0.11^{a}
P-Value	0.04	<0.01	<0.01	0.42^{ns}	0.21	<0.01

Means on the same column with different superscript are statistically significant ($p<0.05$); ns = not significant

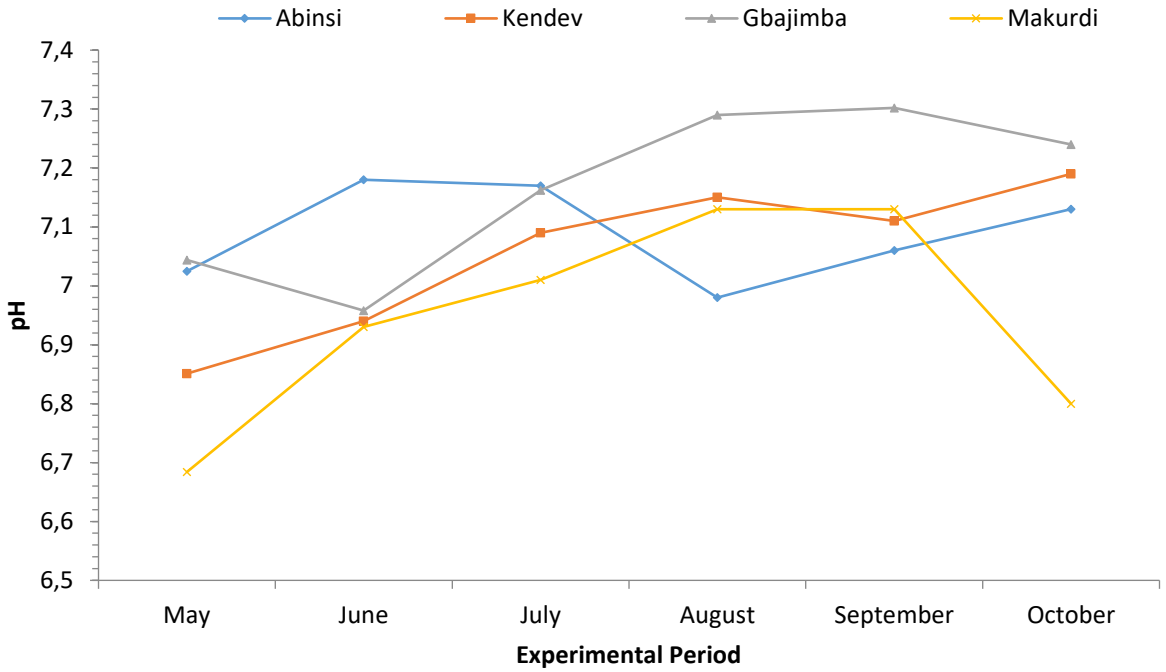


Fig: 1 pH trend along River Benue within the period under review.

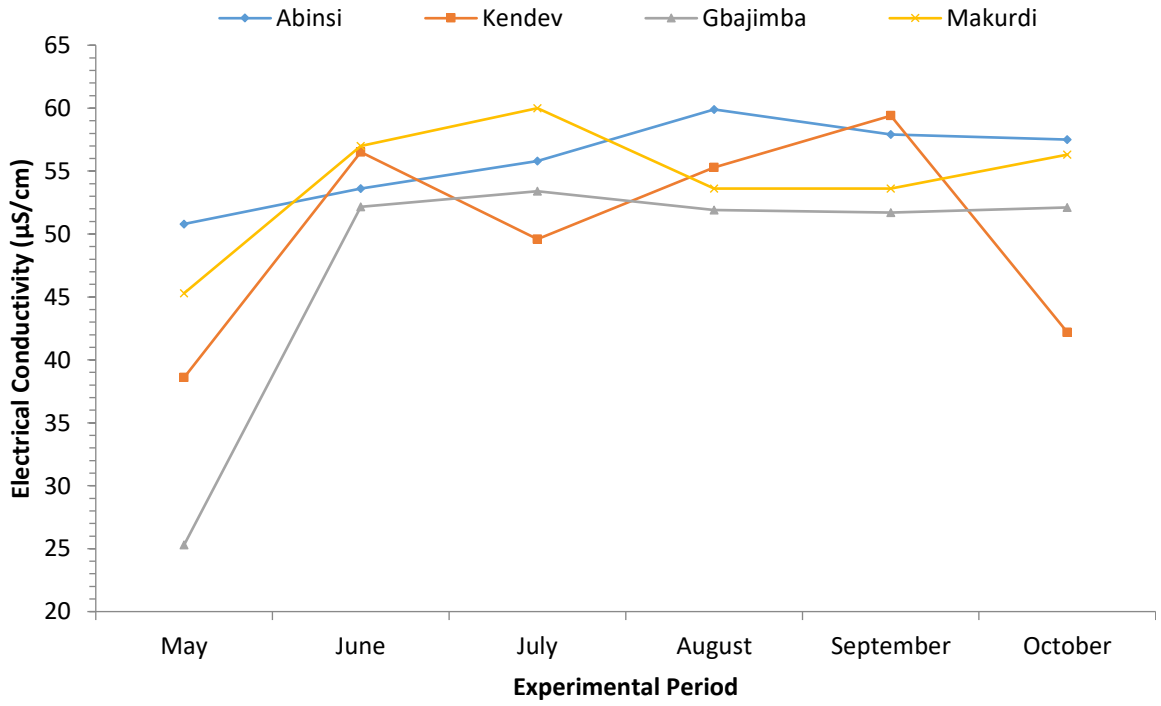


Fig: 2 Electrical conductivity trend in the study area within the period under review.

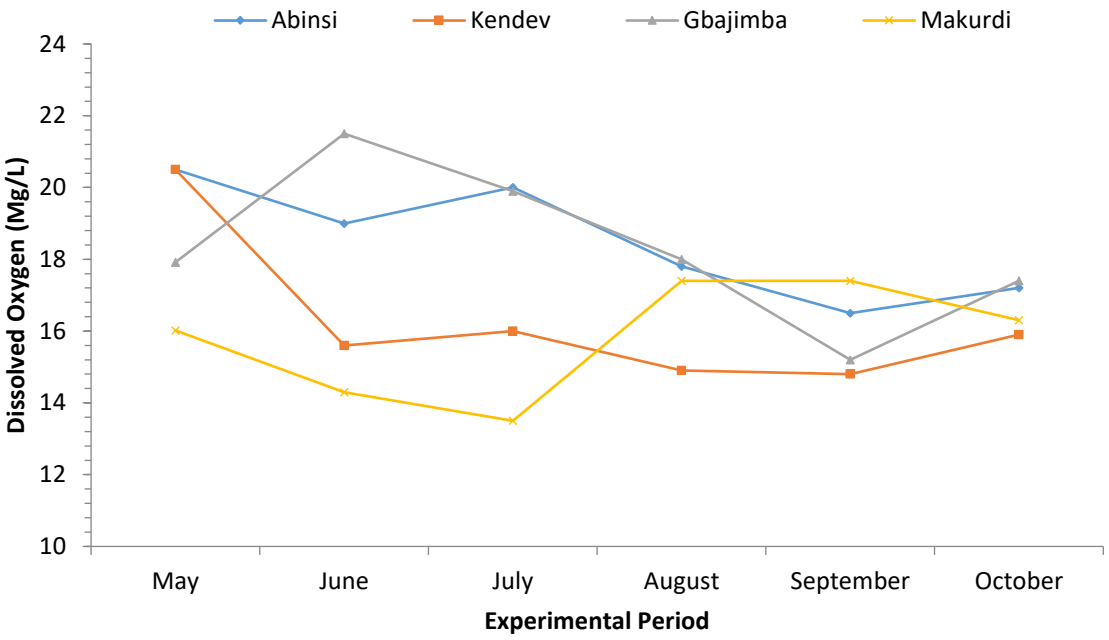


Fig: 3 Dissolved Oxygen trend in the study area within the period under review.

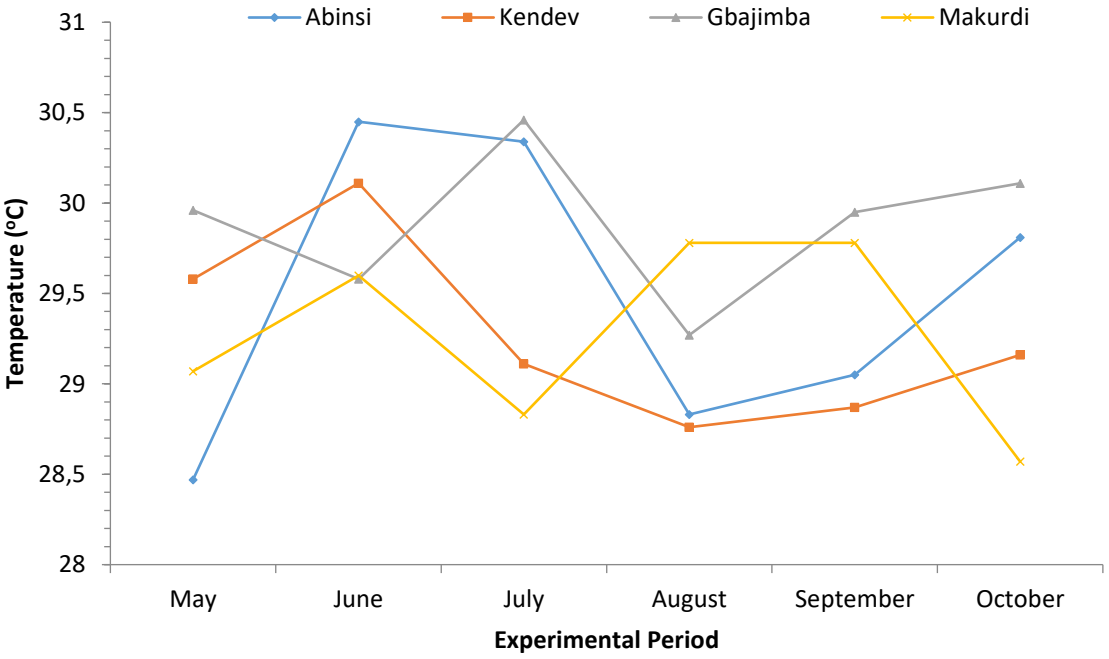


Fig: 4 Temperature trend in the study area within the period under review.

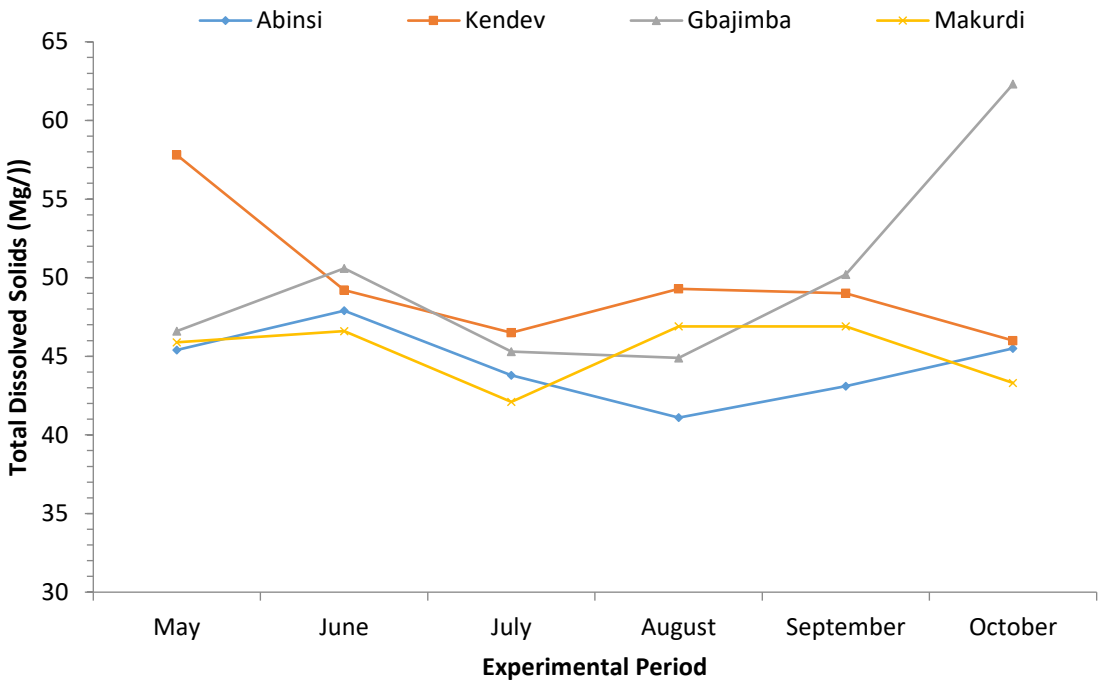
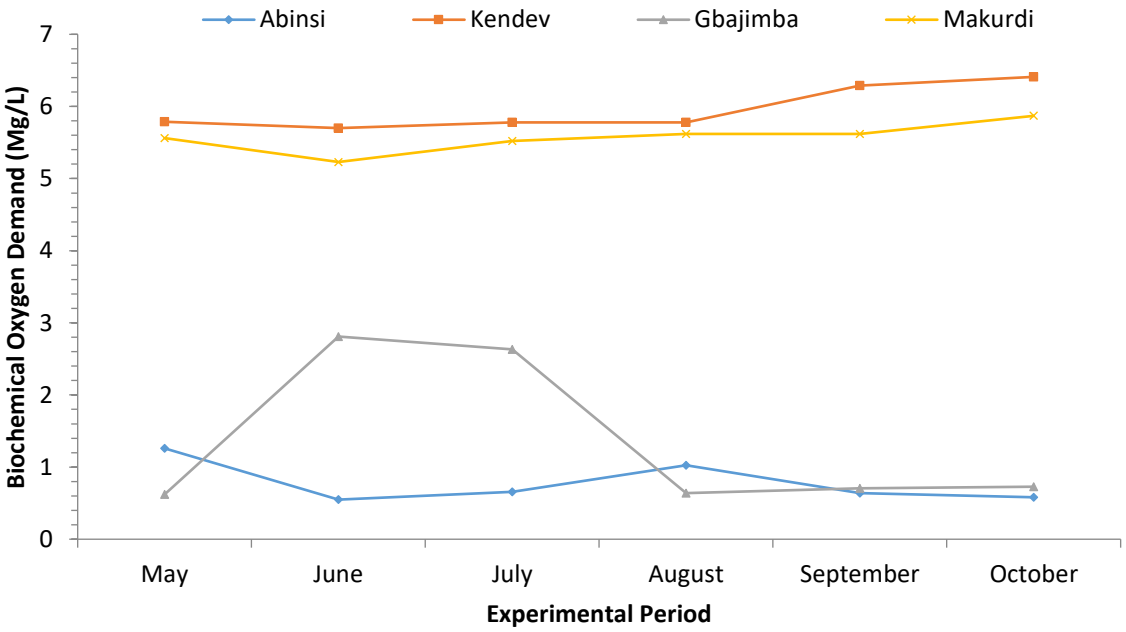


Fig: 5 Total dissolved solids trend in the study area within the period under review.



BOD

Fig: 6 Biological Oxygen Demand trend in the study area within the period under review.

The Biological Oxygen demand (BOD) was high for Abinsi and Makurdi and indicate only very slight variations, while it was low in Gbajimba and Gbeji-Kendev. Habitat selection is defined as a non-random use of Space by animals resulting from voluntary movements which can range from simple Locomotor responses to behaviourally sophisticated decisions (Luiselli *et al.* 2012). However, Smith (1993) reported that Temperature is the overriding factor determining the geographic extent of suitable habitat available to Manatees. Water Temperature is important because it affects the rate of biological and chemical processes. The Temperature range of the study area falls within the range acceptable for Manatee habitation and survival. Temperature also affects the volume of dissolved Oxygen (DO) the water can hold and the rate of Photosynthesis by aquatic plants. The value of the Dissolved Oxygen which ranges between 15.82 to 18.50mg/L is ideal for aquatic life forms when there is mixing of the water. The Electrical conductivity of water is directly related to the concentration of dissolved solids in the water. Ions from the dissolved solids influence the ability of the water to conduct an Electrical current.

As conclusion, much of the information concerning the ecological component of Manatee is gathered in an attempt to better identify the threat to their population. This research tries to provide an overview of existing scientific information on the water health of the Manatee habitat. it is a baseline information and it is suggested that continuous monitoring of water parameters be sustained to evaluate changes that may negatively affect the species as well as other aquatic species along the River Benue.

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